Biospectra : ISSN: 0973-7057, Vol. 20(1), March, 2025, pp. 33-42
An International Biannual Refereed Journal of Life Sciences

Animal Science

ISSN : 0973-7057

A comparative assessment of soil organic content from different ecological habitats

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Received : 25th November, 2024 ; Revised : 04th January, 2025
DOI:-https://doi.org/10.5281/zenodo.15732027

Abstract- This research examines the organic matter content and related physicochemical properties of soils from four diverse ecological settings: agricultural land, forested areas, aquatic zones, and gardens. The Walkley–Black method was employed to determine organic matter levels, alongside assessments of temperature, pH, electrical conductivity, total alkalinity, and the concentrations of carbon, nitrogen, and phosphorus. The analysis revealed significant variations in soil attributes among the habitats. Garden and agricultural soils demonstrated the highest organic matter and conductivity values, whereas forest and aquatic soils exhibited comparatively lower readings. Soil pH ranged from acidic to nearly neutral, affecting both nutrient availability and microbial functions. Forest soils had the greatest phosphorus content, indicating active nutrient cycling in undisturbed ecosystems. These findings emphasize the role of vegetation cover and land use practices in shaping soil quality and nutrient dynamics, highlighting the critical role of organic matter in maintaining ecosystem productivity.

Keywords: Soil, organic content, phosphorous, humus.

INTRODUCTION

The term "soil" refers to an extensive category that includes the shallow upper layers of the earth's surface that have been transformed into an appropriate habitat for plant root systems, burrowing and permanently residing animals, and a variety of microorganisms that serve as a bridge between the chemical phases of the soil and the metabolic phases of higher organisms through weathering of underlying rocks, intimate association with life processes, and organic remains of plants, animals, and microorganisms.[1]

The features of the soil as a habitat are distinct. It creates an environment favorable for the intricate root system and gives the above-ground vegetation mechanical support.[2] Through their roots, these producers dig through the Earth, taking up the essential elements. The community's food source is the organic matter from the above-ground flora because the soil lacks producers in its own right. Detritivores and decomposers make up the majority of the soil community. They work slowly to break down organic materials, releasing nutrients and shifting the biogeochemical cycles that support terrestrial species.

One byproduct of decomposition is soil. The two primary components of its solid phase are organic matter, which is added by plants and animals gradually colonizing the parent rock material, and mineral matter, which is produced by the weathering of the parent rock material.[3] Then, with the aid of physical, chemical, and biological processes, both components decompose. Subsequently, they merge closely to create organo-mineral complexes that define the developed soil.

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Soil formation:

Another name for soil formation is pedogenesis, which comes from the Greek terms pedon, which means "ground," and genesis, which means "birth" or "origin."[4] Weathering is the process that turns parent rock material into soil. There are three primary categories of weathering agents: chemical, biological, and physical.

Physical decomposition:

The mechanical weathering or disintegration of rocks is the initial stage in the production of soil. Deep fissures are caused by variations in pressure, thermal expansions, contractions, wetting and drying, and rock movement scraping. The colonizing plants' roots aid in forcing the fractures open so that they shatter into smaller fragments. More of the rock material is exposed to the process of mechanical weathering as a result of these being carried downward by wind and water currents. The entire surface area of the rock material is exposed to air, water, and agents of chemical and biological degradation due to this physical weathering mechanism. Unlike soil that develops in situ above parent rock and is referred to as sedentary soil, soil generated from transported rock is called transported soil. Rock fragments are being broken up into ever-smaller pieces by mechanical forces.

Soil formation is directly impacted by climate. Physical weathering is the result of heat, cold, wind, water, and ice breaking apart and losing rocks.[5] When water in cracks in rocks freezes, it expands and causes the rocks to fracture. Rocks are eroded by wind and water, and glaciers' gradual movement wears them down to nothing. The rate at which parent materials undergo chemical weathering-a process by which preexisting minerals disintegrate into new mineral components-is also influenced by climate. Chemical weathering proceeds most quickly in warm, humid areas and most slowly in cold, dry ones. Climate affects the types of plant growth that take place, which in turn affects the forming soil. Low levels of rainfall or recurrent droughts frequently promote the growth of grass but inhibit the growth of trees. Low in humus are soils that grow in cool, rainy climates that are ideal for pine and other needle-leaf trees.

Relief, or topography, has a significant role in the development of soil. The amount of rainfall that runs off the surface and the amount that the soil retains is influenced by the slope at which the soil originates. Relief may have an impact on a soil's average temperature based on whether or not the slope faces the sun for the majority of the day.

The other soil-forming components' activities significantly impact how long it takes for soil to develop. Alluvium, or the sediments left behind by floods, or volcanic ash can form young soils in a matter of days. It could take hundreds of thousands of years for other soils to form. The soils in certain places might be older than a million years.

Chemical decomposition:

Chemical reactions begin even in the early phases of physical breakdown. Because they may survive on exposed rock surfaces, lichens and mosses do well on the extremely limited amount of nutrients that are created by the direct solvent action of chemicals generated by the fungal symbiont.

Three primary processes are involved in chemical weathering: dissolution, oxidation, and acid hydrolysis. On the exposed surfaces, all of these processes, or combinations of them, take place at the same time.

(a) Dissolution

Water coming into contact with exposed surfaces causes dissolution, the most basic kind of chemical weathering. After being dissolved, the soluble minerals can be transported or used.

$NaCl + H_2O \longrightarrow Na^+ + Cl^-$ (aq.) Eq......1

(b) Oxidation

Air and water react to oxidize the exposed surfaces that contain reduced material. For example, colloidal ferric hydroxide is formed when ferrous silicates oxidize and precipitates when dehydrated.

$FeSiO_4 + 1/2O_2 + 5H_2O \rightarrow 2Fe(OH)_3 + H_4SiO_4$ Eq…..2

(c) Hydrolysis

In this process, water interacts chemically with minerals in addition to serving as a dissolving agent.

$Mg_2SiO_4 + 4H_2O \longrightarrow 2Mg(OH)_2 + H_4SiO_4$ Eq…..3

$CaCO_3 + 2H_2O \longrightarrow Ca(OH)_2 + H_2CO_3$ Eq…..4

(d) Acid hydrolysis

Weak acids like silicic and carbonic acid were made in the preceding step; powerful acids like nitric acid and sulfuric acid are created when SOx and NOx dissolve in the atmosphere and are carried down by precipitation. Additionally, sulfates are hydrolyzed to produce it.

$Fe(SO_4)_3 + 6H_2O \longrightarrow 2Fe(OH)_3 + 3H_2SO_4$ Eq…..5

These acids then hydrolyze minerals, which extract them from the parent material.

$Mg_2SiO_4 + 4H_2CO_3 \rightarrow 2Mg^{2+} + 4HCO_3^- + H_4SiO_4$ Eq…..6

Soluble minerals are discharged into solution during chemical breakdown and either absorbed on the negatively charged colloidal particle surface or leached or washed away. Rocks weather chemically, breaking down into smaller fragments. The rock gets broken down into ever-finer particles in the following order as weathering continues:

Stones → gravel → coarse sand → fine sand → silt → clay

The material cascade system first produces sand, which is subsequently transformed into clay. Silicon, aluminium, magnesium, oxygen, and hydrogen make up all clay minerals; the first three are the main components of the lithosphere (sial and sima). There are vacant spots of negative charge on the surfaces of the clay minerals. Loosely attached to these negative sites are positive ions, such as hydrogen ions and metallic ions, including potassium and calcium. The quantity of accessible sites on clay and organic matter is expressed as the cation exchange capacity (CEC). Illite, smectite, muscovite, montmorillonite, and kaolinite are the common minerals found in clay.

Biological decomposition

The physical, chemical, and biological agents of weathering operate in tandem. The first invaders, such as lichens and mosses, gradually hydrolyze the rock material for their mineral needs.[6] They create biological material and store energy. On this organic stuff, microorganisms get to work. Numerous bacteria, including those that break down carbon, nitrogen, sulfur, phosphorus, and iron, transform rock into a dynamic system that releases minerals to keep the successional phases active.

A variety of creatures, including millipedes and earthworms, are among the detritus feeders that break down the organic material. The complex material known as humus is created from these broken pieces by bacteria in alkaline soils and fungi in acidic soils. Humus is a complicated mixture of numerous chemicals rather than a single, clearly defined chemical entity. Some water-soluble organic compounds, such as sugars and amino acids, are present in this complex, but humic acid, fluvic acid, and humin make up the vast majority of the insoluble, dark-colored material. The initial stage of organic decomposition is the formation of humus, and the second stage is the gradual dissolution of this rather stable compound.

The resulting organic complexes mix with clay and minerals to create organo-metallic and organo-clay complexes. More organic matter accumulates throughout succession, and complexes that can support the upcoming seral stages subsequently form as a result. A mature soil profile forms over the parent bedrock due to these processes.

Soil profile

A segment of soil that runs from the surface to the parent bedrock underneath is called a soil profile.[7] Mature soil has a distinct structure that varies depending on the surroundings. The series of occurrences results in distinct soil layering. Soil horizons refer to each layer. A horizon is a section of soil that acquires distinctive chemical and physical characteristics. The phrase "soil profile" refers to a set of horizons that are typical of a given soil. The soil profile typically consists of the following five horizon: O horizon, A horizon, B horizon, C horizon and R horizon. Soil organic matter is primarily found in the O and A horizons out of the five soil profile horizons.

(i) O horizon: The O horizon is the uppermost stratum of soil. It is made up of organic material, such as leaves, that is either new or decomposing rather than any worn rock fragments. Desert soils lack an O horizon, although forest soils do.

(ii)A horizon: The A horizon is the following stratum. This topsoil is made up of finely divided organic material that has been thoroughly mixed with the soil. Because there is a larger amount of humus in the upper half of the horizon, it is quite black and has a greyish-brown color, whereas the lower half is lighter because there is less humus in it. Here, the detritivores and decomposers are always attacking and dissolving the dead organic waste. The end products seep into the ground and condense into humus. Because of the humus, the soil is loamy, granular, porous, and has good drainage and aeration. Since the stratum is a rich supply of food materials for many species, the majority of plant and animal life can be found here. Tree roots, on the other hand, delve farther down into the water table. The richest layer of microorganisms is found beneath the top soil's surface. It is the area where finely divided or soluble elements are typically removed to the lower layers by rainwater percolating downward.

Under forests and grasslands, profiles are well-defined and referred to be zonal. Alternatively, profiles might be of an intermediate kind, known as intrazonal, or they can be poorly developed, as in the case of alluvial or desert soils. Thus, terrain and climate have a significant impact on the kind of profile that forms.

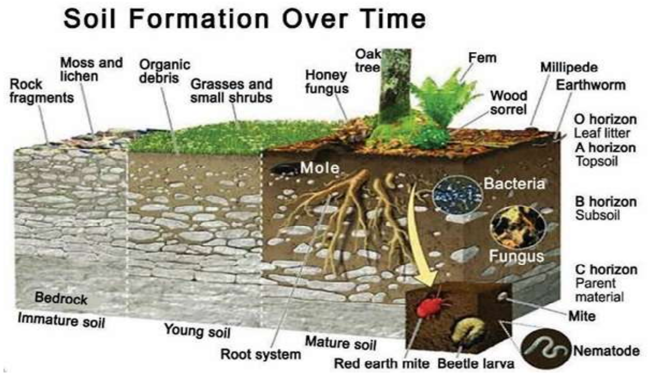

Figure 1: Formation of soil

SOIL ORGANIC CONTENT:

For nutrition and energy, almost all soil life is dependent on decomposing organic materials.[8] Organic substances decompose to varying degrees as a result of the actions of different species. The original dead fragments are transported and communicated by the soil fauna, which is the first stage in the production of organic matter. Earthworms are amazing at moving and incorporating litter; they pull it into their underground tunnels and immediately eat it.[9] The leftovers of this ground and the broken-down litter are combined into castings that are abandoned in burrows at both the surface and the depths. Even though they are less mobile, other organisms including slugs, snails, isopods, millipedes, and dipterous larvae are crucial to the disintegration and movement of litter. These animals also quickly infect the entire litter mass with a variety of bacterial and fungal spores.

In the subsequent phase, heterotrophic bacteria and saprophytes absorb the partially broken down and partially digested material.[10] If it weren't for this crucial function, all the nutrients would quickly be trapped in the corpses of the creatures. The fungal mycelia and bacterial cells include sets of enzymes required for particular chemical processes. These enzymes are secreted into decomposing organic materials; part of the byproducts is taken up by the organisms and used as food, while the remaining products are either removed from the cell or stay in the environment.

Complete decomposition cannot be produced by a single type of saprotroph. On the other hand, a variety of species can influence total decomposition through their gradual actions within decomposer populations. Soluble organics are released and humus is produced rather quickly as a result of the action of microorganisms. The release of inorganic nutrients and the gradual mineralization of humus constitute the third stage. These nutrients are subsequently recycled via the biogeochemical cycles.

Objective

The objective of this study was to explore the organic matter content of various soils, varying from forest floor to pond bottom, and we proposed that as flora grows, the amount of organic matter should also rise since the amount of organic matter regulates productivity through the release of carbon and nutrients by decomposition of soil humus.

METHODOLOGY

1. SOIL ALKALINITY:

Alkalinity is the amount of acid required in order to release all the bound carbon into free carbon dioxide or its free form.[11]

In general, there are two types of alkalinities: Phenolphthalein Alkalinity (PA) and Methyl orange Alkalinity (MA). While the Total Alkalinity (TA) is the sum of Phenolphthalein Alkalinity (PA) and Methyl orange Alkalinity (MA), that is (TA = PA + MA).

Reagent:

1. 0.02 N Sulphuric acid: 30 ml of concentrated acid is added to one litre of distilled water to give 1N stock solution. 20ml of this solution is diluted in one litre of distilled water to make an approximate 0,02 N solution.
2. Phenolphthalein indicator: 0.5gm of phenol phthalein is dissolved in 50 percent alcohol.
3. Methyl orange indicator: 0.5gm of methyl orange is dissolved in 100ml of distilled water.
4. N/22 Sodium carbonate: 0.482gm of sodium carbonate is dissolved in 200ml of distilled water.

Procedure:

First of all, air dry the soil samples. Then sieve the soil sample through No. 10 sieve (2 mm mesh) to remove the coarser soil fraction. Weight out approximately 20 grams of air dried and sieved soil sample. Place the soil into a 100 ml beaker and add approximately 40 ml of distilled water. The sample is then stirred with a glass rod and let stand for an hour with intermittent stirring.

Phenolphthalein alkalinity:

Two drops of phenolphthalein indicator are added to 10 milliliters of the prepared sample in a conical flask. If the solution is colourless, the sample does not include carbonates. The sample must next be titrated with N/22

Na_2CO_3 solution until it turns pink. If the solution turns pink, it indicates that the sample contains carbonates. Titrate the sample with N/50 H_2SO_4 until the solution is colourless. The titre reading is noted and multiplied by 100 to obtain the concentration in mgL^{-1}.

Methyl orange alkalinity:

One drop of methyl orange indicator is applied to ten milliliters of the prepared sample. The solution turns yellow, which is followed by a tint of orange when 0.02 N H_2SO_4 is added. The concentration in milliliters per litre is calculated by multiplying the titre reading by 100.

Observation

Table 1: Variations in the alkalinity of different habitats in milli-equivalents per litre.

HABITAT	Ph. ALK (mgL^{-1})	Mo. ALK (mg/l)	TOTAL ALK (mg/l)	TOTAL ALK (meq./l)
Agriculture	150	10	160	3.2
Forest	5	20	25	0.5
Aquatic	10	10	20	0.4
Garden	10	50	60	1.2

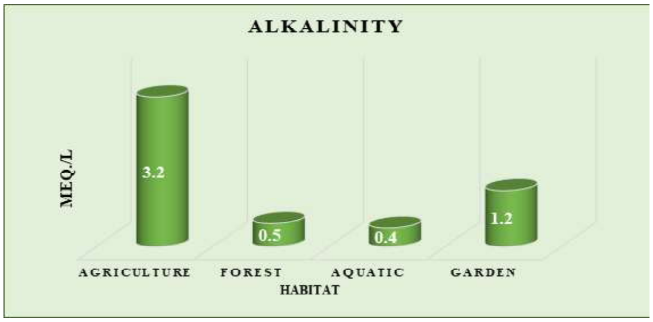

Figure 2: The difference in alkalinity (milli-equivalents per liter) between different habitats.

2. SOIL CONDUCTIVITY:

Soil electrical conductivity (EC) is a measure of the ability of soil to carry electrical current. Generally, the conductivity of soil ranges from 110-570 milliSiemens per meter (mS/m).[12] Reduced conductivity values signify inadequate nutrient availability, while extremely high values suggest an abundance of nutrients. It is among the crucial factors in figuring out the soil's quality. Soil samples' conductivity can be measured to determine whether surface and groundwater are contaminated.

Higher conductivity indicates the presence of ions that are beneficial to plants, such as chlorides (Cl-), sulphate (SO_4^{2-}), nitrites (NO_2^-), nitrates, (NO_3^-) and positively charged ions like sodium (Na^+), ammonium (NH_4^+), potassium (K^+), calcium (Ca_2^+), magnesium (Mg_2^+), hydrogen (H^+), iron (Fe_2^+ /Fe_2^+), copper (Cu_2^+), zinc (Zn_2^+) and manganese (Mn_2^+).

Procedure:

- Calibrate the conductivity cell: Refer to the instrument manual.
- Determine the cell constant: Rinse and dip the conductivity cell 0.1N KCl and record the conductance observed. Note down the temperature. Wash the conductivity cell with distilled water and measure the conductance for 0.01 N KCl.
- Measure the conductivity:

a) Measure the conductance of distilled water by dipping the conductivity cell in distilled water.

b) Take 1 g of soil sample in a 100 mL beaker and add 100 mL of water. Stir the suspension for 30 min and filter. Rise and dip the conductivity cell in the filtered solution. Record the conductance observed. Note down the temperature. Clean the conductivity cell after use.

Observation

Table 2: Variations in the Conductivity of different habitats in µS/m.

HABITAT	TEMP (°C)	CONDUCTIVITY (mS/m)	CONDUCTIVITY (µS/m)
Agriculture	32.7	0.4	400
Forest	32.6	0.2	200
Aquatic	33.1	0.36	360
Garden	32.3	1.96	1960

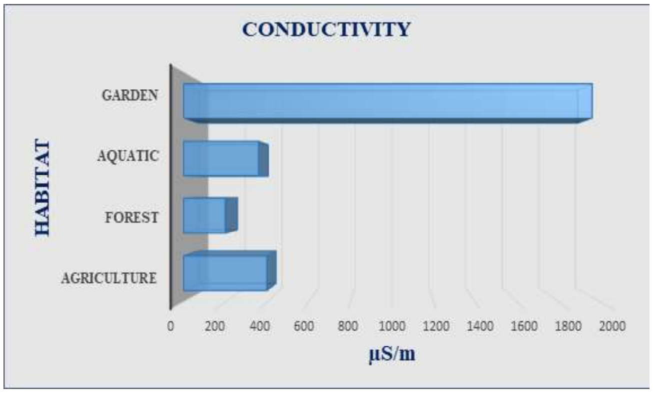

Figure 3: The difference in Conductivity (µS/m) between different habitats.

3. SOIL pH:

pH of the soil is measured using a portable pH meter. A soil's acidity or basicity can be determined by measuring its pH. One important factor that may be utilized to create insightful qualitative and quantitative analyses of soil features is the pH of the soil.[13] The negative logarithm of the hydronium ion activity in a solution is known as pH.

Generally, soil pH 6.0-7.5 is acceptable for most plants as most nutrients become available in this pH range. Soil pH is important because it affects the availability of nutrients to plants. Nitrogen, phosphorus, and potassium are the primary nutrients needed in fairly large quantities.

The correct balance is where the soil pH is between 5.5 and 7.5, so every effort should be taken to check soil pH levels regularly. Early identification of soil pH problems is important as it can be both costly and difficult to correct long-term nutrient deficiencies.

The pH of a soil is a measure of the hydrogen ion concentration in the soil solution. pH is the negative logarithm of H+ concentration in moles / liter: pH = - log [H+] and is therefore a solution measurement which only reflects the presence of acid cations adsorbed on soil colloids.

Procedure:

First of all, air dry the soil samples. Then sieve the soil sample through No. 10 sieve (2 mm mesh) to remove the coarser soil fraction. Weight out approximately 20 grams of air dried and sieved soil sample. Place the soil into a 100 ml beaker and add approximately 40 ml of distilled water. The sample is then stirred with a glass rod and let stand for an hour with intermittent stirring. Take the pH readings with the help of a pH meter.

Observation

Table 3: Variations in the pH values of different habitats.

HABITAT	TEMP (°C)	pH
Agriculture	32.7	5.17
Forest	32.6	5.11
Aquatic	33.1	6.78
Garden	32.3	4.97

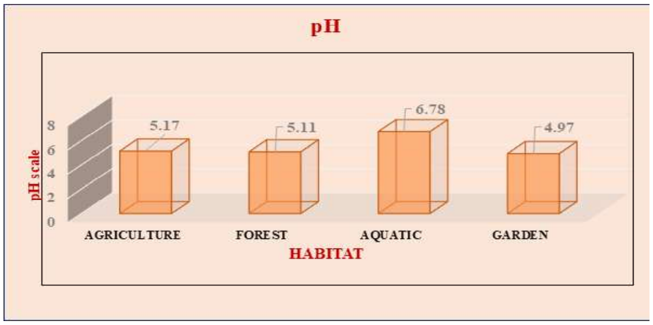

Figure 4: The difference in pH values between different habitats.

4. SOIL PHOSPHOROUS:

The small amounts of soil P extracted by water (mainly P in dissolved forms) and difficulties related to chemical analysis limit the use of water as an extractant.

The soil contains both organic and inorganic forms of phosphorus (P). Compared to the other forms, the inorganic P forms are more readily absorbed by plants. The majority of inorganic P forms are mixtures of calcium (Ca-P), iron (Fe-P), and aluminum (Al-P) phosphates; the proportions of these three forms depend on the pH of the soil, with higher Ca-P percentages in neutral to alkaline soils and higher percentages of Al-P and Fe-P in acidic soils.

There are two forms of soil analysis for P: total analysis and fractional analysis. The second group is matched by the P-Olsen. The proportions of this element in the soil need to be connected to how plants react when phosphate fertilizer is applied. P fractions can be extracted using a variety of techniques, each producing a unique set of generated values. But these are only significant when they are connected to the plants' reaction. Phosphorus is extracted using the Olsen technique with a 0.5 M $NaHCO_3$ solution that has been pH- adjusted to 8.5.

The Olsen method uses an extractant called $NaHCO_3$, which is capable of removing both Al-phosphates and Ca-phosphates that have been adsorbed on the surfaces of calcium and magnesium carbonates.[14] 0.5 M $NaHCO_3$ is used to extract phosphorus from the soil at a pH of 8.5 that is almost constant.

Using spectroscopic techniques, phosphorus is measured or determined based on color development. Because molybdenum blue methods are the most sensitive throughout the coloring process, they are frequently used for determining the total P content of soils as well as for extracts from soils that contain modest amounts of phosphate. These methods work on the basis that an acid molybdate solution containing orthophosphate ions forms phosphomolybdate complex, which can be reduced in the presence of potassium antimony tartrate by ascorbic acid or other reducing agents (e.g., $SnCl_2$) to form a blue-colored heteropolymolybdic complex. Antimony speeds up the blue color's development and holds it steady for up to 24 hours.

According to Beer's Law, the intensity of the blue color changes with the concentration of P, but it is also influenced by other elements like acidity, arsenates, silicates, and compounds that alter the system's oxidationreduction conditions. Using spectrophotometry, the concentration of P is measured at 885 nm.[15,16]

Extraction:

2.5 grams of soil is taken in a beaker and 30 ml of extractant (0.5 M $NaHCO_3$) is added to it (prepared by taking 42 grams of Sodium Bicarbonate in one litre of distilled water and pH adjusted to 8.5). Further, a pinch of activated Charcoal is added to the sample. The solution is then placed in horizontal shaker for about 30 minutes. After constant shaking, the sample is filtered with Whatman paper No.1. Thereafter, 10 ml of the extracted sample is taken in a conical flask and 1-2 drops of 2,4-Dichlorophenoxy acetic acid indicator is added to it. The solution turns faint yellow in colour. Again 1-2 drops of 1N H_2SO_4 is added or until it becomes colourless. The extractant is ready.

Reagents:

(i) Ammonium molybdate reagent:15 grams of ammonium molybdate is dissolved in 500 ml of distilled water.

(ii) Sulphuric acid reagent: 70 ml of H_2SO_4 is dissolved in 450 ml of distilled water.

(iii) Ascorbic acid solution: 5.4 grams of ascorbic acid is dissolved in 100 ml of distilled water.

(iv) Potassium antimonyl tartarate: 0.34 grams of Potassium antimonyl tartarate is dissolved in 250 ml of distilled water.

(v) Mixed reagent: 20 ml ammonium molybdate, 50 ml sulphuric acid reagent, 20 ml ascorbic acid solution and 1 ml of potassium antimonyl tartarate are mixed together.

Procedure:

For the preparation of phosphate standard, we use anhydrous potassium dihydrogen phosphate. Dissolve 4.39 grams of KH_2PO_4 in 1000 ml of distilled water (Or) 0.439 grams of KH_2PO_4 in 100 ml of distilled water.

Step 1 dilution:

Dilute 1 ml of the solution in 99 ml of distilled water

So, 100 ml contains 1 mg of PO_4 - P and the concentration = 10 mg/l. Therefore, 1 ml of the above diluted solution contains, 0.01 mg of PO_4 - P.

Step 2 dilution:

Prepare standards with this solution:

1. 1 ml in 99 ml of distilled water = 0.1mg/l
2. 2 ml in 98 ml of distilled water = 0.2 mg/l
3. 3 ml in 97 ml of distilled water = 0.3 mg/l
4. 4 ml in 96 ml of distilled water = 0.4 mg/l
5. 5 ml in 95 ml of distilled water = 0.5 mg/l
6. 6 ml in 94 ml of distilled water = 0.6 mg/l

Next, 90 milliliters of distilled water are added to 10 milliliters of the extractant. Ten milliliters of the mixed reagent need to be added which is a mixture of 2 ml of ammonium molybdate reagent, 5 ml sulphuric acid, 2 ml ascorbic acid reagent and 1 ml of potassium antimonyl tartarate solution. A blue colour develops. Read the absorbance at 885nm.

Observation:

Table 4: The concentration and absorbance values of the standard phosphate samples.

CONCENTRATION	ABSORBANCE
1	0.139
2	0.345
3	0.365
4	0.378
5	0.429
6	0.439

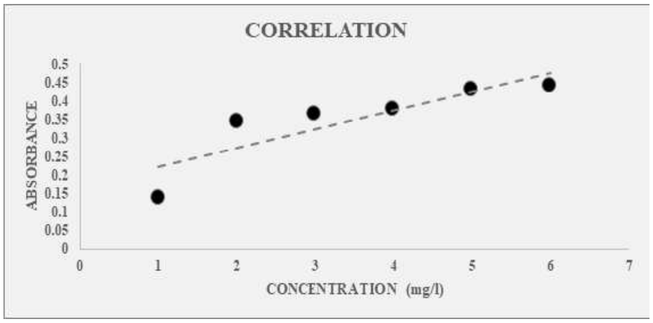

Figure 5: Correlation between concentration and absorbance.

Table 5: Variations in the Phosphorous concentration of different habitats.

HABITAT	ABSORBANCE	CONCENTRATION (gms/ml)	PERCENTAGE
Agriculture	0.174	0.1815	7.26
Forest	0.998	0.2229	8.916
Aquatic	0.135	0.1792	7.168
Garden	0.377	0.1917	7.668

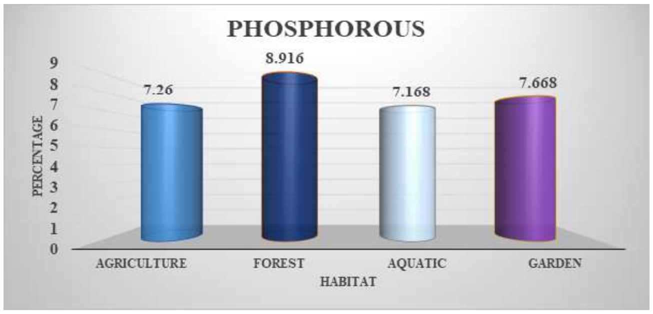

Figure 6: The difference in Phosphorous content between different habitats.

5. SOIL ORGANIC CONTENT:

Soil organic content is measured by Walkely - Black Method (1934)[17,18]. Dead organic matter found in the soil provides nutrients and energy that are essential to almost all soil life. It is therefore a major factor in determining soil fertility. The availability of organic matter is based on organic detritus, which includes deceased animals and organic debris such as stems, leaves, and roots. Then detritivores and decomposers take action on these. Different degrees of organic matter breakdown and the release of mineral nutrients are the results of the activity. Humus refers to the biological substance that has broken down. Plant nutrients originate from the organic matter in the soil and are released in a form that is easily assimilated through microbial decomposition. In very sandy soil, the organic content ranges from 0.344 percent to 86 percent in peat-rich soil. The amount of carbon in the soil is used to assess its organic matter content, which usually ranges from 52 to 58 percent.

Principle:

The Walkely - Black Method (1934) is based upon the oxidation of organic carbon present in the humus by nascent oxygen liberated from potassium dichromate in the presence of sulphuric acid. A known weight of the soil is treated with an excess of potassium dichromate in the presence of concentrated sulphuric acid. The soil is slowly digested by the heat of dilution of sulphuric acid (approximately 120°C) and the organic carbon present in the soil is converted to carbon dioxide.[19]

$K_2Cr_2O_7+4H_2SO_4 \longrightarrow K_2SO_4+Cr_2(SO_4)_3+4H_2O+3[O]$ Eq….7

$3C + 6[O] \longrightarrow 3CO_2$ Eq….8

The excess of potassium dichromate is back titrated against ferrous ammonium sulphate solution, in the presence of sodium fluoride, orthophosphoric acid and diphenylamine indicator.

Reagents:

1. Concentrated orthophosphoric acid (H_3PO_4) 85 percent.
2. Solid sodium fluoride (NaF).
3. Concentrated sulphuric acid (sp.gr. 1.84)
4. Standard 1N potassium dichromate solution ($K_2Cr_2O_7$): 49.03 g of potassium dichromate is dissolved in distilled water and the volume is made to one litre.
5. Diphenylamine indicator ($C_6H_5NHC_6H_5$): 0.5 g of diphenylamine indicator is dissolved in a mixture of 100 ml concentrated sulphuric acid and 20 ml distilled water.
6. Ferrous ammonium sulphate solution (0.5N): 196 g of ferrous ammonium sulphate [$Fe(NH_4)_2(SO_4)_2 . 6H_2O$] is dissolved in 800 ml of distilled water containing 20 ml concentrated sulphuric acid and the resulting solution is diluted to one litre. This is then standardized against 1N potassium dichromate.

Procedure:

Put the labels such as Blank, Agriculture, Forest, Aquatic, and Garden on five conical flasks. Add 0.5 g of the appropriate soil into each conical flask with the appropriate label, excluding Blank. Fill each flask with 10 milliliters of $K_2Cr_2O_7$ (potassium dichromate). Fill each flask with 20 ml of concentrated H_2SO_4 and wait for 15 minutes. Carefully fill each flask with 200 milliliters of distilled water. Ten milliliters of orthophosphoric acid should be added to each conical flask. In each of them, add 0.2 g of NaF. Add a total of 30 drops of diphenylamine indicator in each of the sample. A blue-black colour appears. Use a solution of ferrous ammonium sulphate to titrate each sample independently. The ultimate colour shifted to brilliant green, followed by a violet-coloured compound.

Calculations:

The result is calculated from the following equation:

Percent organic matter in the soil sample

(u) = $10\{1-V1/V2\} \times 1.34$

Where,

V_1 = Titre from sample titration

V_2 = Titre from blank titration

The percentage of carbon = u x 0.58 (since only 58 percent carbon occurs in soil organic matter.

The percentage of nitrogen = u x 0.05 (since approximately 5 percent nitrogen occurs in organic matter.

Table 6: Variations in the Percent Organic Matter, Percent Carbon and Percent Nitrogen of different habitats.

HABITAT	ORGANIC MATTER "U" (%)	CARBON (%)	NITROGEN (%)
Agriculture	2.8716	1.6655	0.1436
Forest	1.9143	1.1103	0.0957
Aquatic	1.9143	1.1103	0.0957
Garden	2.8716	1.6655	0.1436

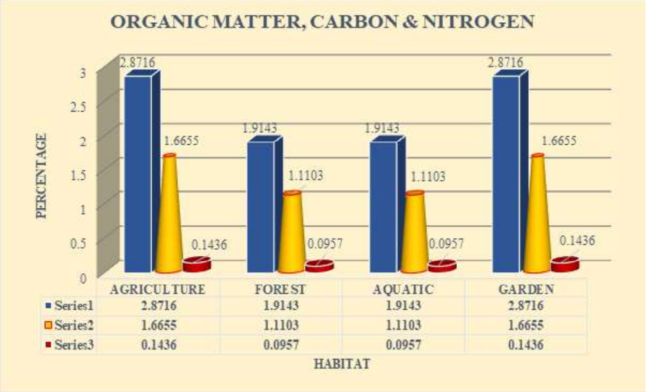

Figure 7: The difference in Percent Organic Matter, Percent Carbon and Percent Nitrogen between different habitats.

RESULT & DISCUSSION

Soil organic matter indicates the equilibrium between input deriving from primary photosynthetic production and degradative and resynthetic activities connected with soil dwelling organisms.[20] Most naturally occurring organic compounds may thus be found at some time in the soil. The intake is generally in the form of carbohydrates lignin compounds, lipids, proteins and with lower quantities of free amino acids, alkanes, terpenoids, carotenoids, flavonoids, alkaloids, polyphenols and resins.

The term soil organic matter encompasses the total non-mineral part of soil and comprises basically of succession of product which range from dead plants and animal tissue to fairly amorphous brown to black material bearing no sign of anatomical structure of a material and is known as soil humus.[21]

The importance of soil organic matter in connection to soil fertility and physical condition are extensively recognised. So, keeping in view of these significance we analyse four habitats as follows: Agriculture field soil, Forest soil, Aquatic soil and Garden soil. We analysed the alkalinity, conductivity, pH, phosphorous concentration, soil organic matter, organic carbon and organic nitrogen of all the four habitats.

The alkalinity varies over a wide range. For aquatic, forest and Garden soil the alkalinity is more or less similar that was 0.4, 0.5 and 1.2 meq.L^{-1} respectively. But the agricultural field soil had a greatest alkalinity that was 3.2 meq.L^{-1}. The maximum conductivity was found in the garden soil with the value of 1960 µS/m while in the soil environment the values decreased from agricultural field soil - aquatic soil - forest soil that was 400 - 360 - 200 µS/m respectively. In our study we found the garden, forest and agriculture field soils to the acidic (4.97, 5.11 and 5.17 respectively) while the one that is the aquatic soil had a pH 6.78 which represents the normal soil. Plants take up nutrients from exchange pool present in the soil. The exchange pool receives input of nutrients from weathering of parent rock material, rainfall and decomposition of organic matter in the system. In our research, we discovered that the highest phosphate concentration was 8.916% in forest soil and the lowest was 7.168% in aquatic soil. Conversely, the phosphorus concentrations in the garden and agricultural field soil were 7.668% and 7.26%, respectively. The concentration of phosphorous decreases as follows: Forest soil > Garden soil > Agriculture field soil > Aquatic soil. The highest amount of soil organic matter, 2.8716 %, was discovered in garden and agricultural field soil, while it decreased to 1.914% in aquatic and forest soil. As a result, soil nitrogen and organic carbon levels exhibit abundance in the same order.

CONCLUSION

Our research leads us to the conclusion that the highest amount of organic matter was discovered in soil with vegetation cover, such as gardens and agricultural fields, since a significant portion of this material enters the decomposer compartment and helps to build humus. After that, microbes break down the humus to release and recycle nutrients. The organic matter in the soil serves as a storehouse for carbon and other nutrients that greatly contribute towards the productivity of system.

ACKNOWLEDGEMENT

I express my heartfelt gratitude to my mentor and supervisor Late Professor. (Dr.) Biswarup Mukherjee, D.Sc., University Professor, University Department of Zoology, Ranchi University, Ranchi. The knowledge I acquired from his supervision will be the most valuable asset for my academic career. I also express my sincere thanks to Dr. Nayni Saxena, Associate Professor, University Department of Zoology, Ranchi University, Ranchi for her unconditional support.

REFERENCES

1. **Mitchell, J. K., & Soga, K. 2005.** Fundamentals of soil behavior (Vol. 3, p. USA). New York: John Wiley & Sons.

2. **Grime, J. P. 2006.** Plant strategies, vegetation processes, and ecosystem properties. John Wiley & Sons.

3. **Shahbaz, M., Kuzyakov, Y., Sanaullah, M., Heitkamp, F., Zelenev, V., Kumar, A., & Blagodatskaya, E. 2017.** Microbial decomposition of soil organic matter is mediated by quality and quantity of crop residues: mechanisms and thresholds. *Biology and Fertility of Soils,* **53:**287-301.

4. **Hartemink, A. E. 2016.** The definition of soil since the early 1800s. *Advances in Agronomy,* **137:** 73-126.

5. **Carroll, D. 2012.** Rock weathering. Springer Science & Business Media.

6. **Asthana, D. K. 2001.** Environment: Problems and solutions. S. Chand Publishing.

7. **Phillips, J. D., & Lorz, C. 2008.** Origins and implications of soil layering. *Earth-Science Reviews,* **89(3-4):** 144-155.

8. **Khatoon, H., Solanki, P., Narayan, M., Tewari, L., Rai, J., & Hina Khatoon, C. 2017.** Role of microbes in organic carbon decomposition and maintenance of soil ecosystem. *International Journal of Chemical Studies,* **5(6):** 1648-1656.

9. **Edwards, C. A., & Arancon, N. Q. 2022.** Earthworms as pests and benefactors. In Biology and ecology of earthworms (pp. 335-370). New York, NY: Springer US.

10. **Gupta, A., Gupta, R., & Singh, R. L. 2017.** Microbes and environment. Principles and applications of environmental biotechnology for a sustainable future, 43-84.

11. **Bromham, L., Saslis-Lagoudakis, C. H., Bennett, T. H., & Flowers, T. J. 2013.** Soil alkalinity and salt tolerance: adapting to multiple stresses. *Biology Letters,* **9(5):**20130642.

12. **Bratoev, K., Beloev, H., Mitkov, A., & Mitev, G. 2020.** On the possibility of conducting fast and reliable soil tests. Mechanization in agriculture & Conserving of the resources, **66(2):**71-76.

13. **Jeffery, S., Verheijen, F. G., van der Velde, M., & Bastos, A. C. 2011.** A quantitative review of the effects of biochar application to soils on crop productivity using meta-analysis. *Agriculture, ecosystems & environment.* **144(1):** 175-187.

14. **Maghanga, K. J., Kituyi, L. J., Segor, K. F., & Kisinyo, P. 2015.** Comparison of soil phosphorous extraction by Olsen and double acid methods in acid soils of Western Kenya.

15. **Waterlot, C. 2018.** Alternative approach to the standard, measurements and testing programme used to establish phosphorus fractionation in soils. *Analytica Chimica Acta,* **1003:** 26-33.

16. **Neilsen, G. H., Neilsen, D., Toivonen, P., & Herbert, L. 2008.** Annual bloom-time phosphorus fertigation affects soil phosphorus, apple tree phosphorus nutrition, yield, and fruit quality. HortScience, **43(3):** 885-890.

17. **Jha, P., Biswas, A. K., Lakaria, B. L., Saha, R., Singh, M., & Rao, A. S. 2014.** Predicting total organic carbon content of soils from Walkley and Black analysis. *Communications in soil science and plant analysis*, **45(6):** 713-725.

18. **Bahadori, M., & Tofighi, H. 2017.** Investigation of soil organic carbon recovery by the Walkley-Black method under diverse vegetation systems. Soil science, **182(3):** 101-106.

19. **Stockmann, U., Adams, M. A., Crawford, J. W., Field, D. J., Henakaarchchi, N., Jenkins, M., ... & Zimmermann, M. 2013.** The knowns, known unknowns and unknowns of sequestration of soil organic carbon. *Agriculture, Ecosystems & Environment,* **164:** 80-99.

20. **Kogel-Knabner, I., Wiesmeier, M., & Mayer, S. 2023.** Mechanisms of soil organic carbon sequestration and implications for management.

21. **Blume, H. P., Brümmer, G. W., Fleige, H., Horn, R., Kandeler, E., Kögel-Knabner, I., ... & Wilke, B. M. 2016.** Soil organic matter. Scheffer/SchachtschabelSoil Science, 55-86.

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